FOSSIL FLORAS OF THE CALIFORNIA DESERT CONSERVATION AREA

BY

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for

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FOSSIL FLORAS

M E G A F O S S I L F L O R A S

MISSISSIPIAN

Chainman

Kirk, E. A geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada, California. U. S. Geol. Surv. Prof. Paper 110, p. 38, 1918.

Merriam, C. W. Rocks of Paleozoic age in southern California. In Geology of southern California. Calif. Div. Mines and Geol. Bull 180, Chap. III, p. 9-14, 1954.

Merriam, C. W. Geology of the Cerro Gordo mining district, Inyo County, California. U. S. Geol. Surv. Prof. Paper 408, p. 21-22, 1963.

The oldest vascular plants known in the region occur in the Chainman Shale. Inasmuch as it is largely marine in origin, imprints of land plants are not common. They occur in black shale 1 1/2 miles north of Cerro Gordo Mine (Kirk, 1918, p. 38-9; Merriam 1954, p. 11; Merriam, 1963, p. 21-22). As noted by Merriam, the plants include fucoidal (algal) remains and leaves that resemble those of Calamites, fern-like types, and Cordaites. In addition, specimens of Lepidodendron bark with typical rhomboidal scars have been brought into me for determination. It is possible that a moderate-sized flora can be recovered in the area for the plants indicate a coal swamp environment in the proximity.

The Chainman Shale (= White Pine Shale of Kirk, 1918) is Late Mississippian, about 320 m.yr. old.

Collection. U. S. Nat. Museum, Wash. D. C.,

LATE CRETACEOUS

Willow Tank-Baseline

Hewitt, F. D. et al. Mineral sources of the region around Boulder Dam. U. S. Geol. Surv. Bull. 871: 121-122, 1936.

Longwell, C. R. Structure of the northern Muddy Mountain area, Nevada. Geol. Soc. Amer. Bull. 60: 923-968, 1949.

Read, C. B. and R. W. Brown. American Cretaceous ferns of the genus Tempksya. U. S. Geol. Surv. Prof. Paper 186-F. 1937.

Plant remains occur in the Upper Cretaceous Willow Tank and Baseline Formations in the Muddy Mountains, southern Nevada (Hewitt, et al., 1936, p. 121; Longwell, 1949, p. 931-933; Read and Brown, 1937). The Willow Tank Formation, about 550 feet thick, is exposed in the area 5 miles southwest of Overton where it consists of conglomerate, claystone and tuffaceous sandstone. Unidentifiable woods of conifers and anigosperms are represented as well as stems of the tree fern Tempksya minor. The overlying Baseline Formation, composed of about 3,000 feet of vari-colored sandstone has yielded Equisetum as well as Microtaenia paucifolia, a cycadophyte. The occurrence of Tempksya minor and Microtaenia paucifolia indicate a well-watered region. This is consistent with the occurence in the Baseline Formation of several large leaves that unfortunately are so poorly preserved that they can not be identified. The conditions in the area probably were those of a tropical savanna. It is amply clear that desert climate and vegetation were not yet in existence in this region.

Based on the restricted stratigraphic range of Tempksya and Microtaenia, the flora is judged to be of Turonian age (Read and Brown, 1937), or about 95 m.y. old, in the lower part of the Late Cretaceous.

Collection. U. S. National Museum; Univ. Calif. Mus. Paleontology.

PALEOCENE

Goler

Fairbanks, H. W. Notes on the geology of eastern California. Amer. Geologist 17: 63-74, 1896.

Axelrod, D. I. in A Miocene flora from the western border of the Mohave Desert. Carnegie Inst. Wash. Pub. 516, p. 52, 1939.

Dibblee, T. W. Geology of the Saltdale Quadrangle, California. Calif. Dept. Mines and Geol. Bull. 160: 7-42, 1952.

McKenna, M. C. Paleocene mammal, Goler Formation, Mohave Desert, California. Amer. Assoc. Petrol. Geol. Bull. 39: 512-515, 1955.

McKenna, M. C. A continental Paleocene vertebrate fauna from California. Amer. Mus. Novitates No. 2024: 1-20, 1960.

A small fossil flora is associated with the coal mines in the lower part of the Goler (formerly Mohave) Formation, and also at somewhat higher levels. The plants are preserved in fine-grained sandstones and shales, and leaves appear to be abundant locally. The formation crops out on the north slope of the El Paso Mountains where it rests unconformably on the Precambrian crystalline basement and is locally faulted against it. The Goler is overlain unconformably by the Late Miocene Ricardo Formation (Dibblee, 1952).

Knowlton (in Fairbanks, 1896) recorded a fern Anemia and soapberry (Sapindus) from the coal mine area. Axelrod (1939) added several taxa to the flora which now includes species of Annona, Carya, Celastrus, Combretum?, Juglans, Magnolia, Myrica, Parathesis, Persea, Platanus, and Rhamnidium. Others whose identity is uncertain, owing to poor preservation, are of large size, thick texture and have entire margins. The assemblage represents subtropical vegetation like that now in the mountains from central Mexico southward into Central America. The flora appears to indicate rainfall was near 50-60 inches, distributed chiefly in the warm season, with winters dry and frostless.

The age of the flora is established as Paleocene on the basis of vertebrate remains discovered in the section (McKenna, 1955; 1960). It is possible that the basal beds of the Goler Formation reach down into the Cretaceous transition (+65 m.y.).

Collection. Univ. Calif. Mus. Paleontology.

OLIGOCENE

Titus Canyon

Stock, C. and F. D. Bode. Occurrence of Lower Oligocene mammalian-bearing beds near Death Valley, California. Nat. Acad. Sci. Proc. 21: 571-579, 1935.

Stock, C. Titanotheres from the Titus Canyon Formation, California. Nat. Acad. Sci. Prof. 22: 656-661, 1936.

The Titus Canyon Formation, composed of coarse debris swept off the slopes of the rising Grapevine Mountains, has yielded a mammalian fauna of Early Oligocene age (Chadronian, 30-35 m.y.). A mold of a pine cone is also known from the sequence. Inasmuch as it is not complete, certain identification in terms of modern pines is not possible, though it appears to be a member of the Subsect. Ponderosae group. In any event, it shows that higher hills in the area were covered with pine forests in the Early Oligocene.

Collection. Univ. Calif. Mus. Paleontology.

MIOCENE

Anaverde

Axelrod, D. I. The Anaverde flora of southern California. Carnegie Inst. Wash. Publ. 590: 119-158, 1950.

Wallace, R. E. Structure of a portion of the San Andreas rift in southern California. Geol. Soc. Amer. Bull. 60: 781-806, 1949.

This fossil flora comes from the margin of the Mohave Desert, a few miles west of Palmdale. It is preserved in the lower part of the Anaverde Formation, composed of fine sandstone, some shale and associated conglomerate, all of non-marine origin (Wallace, 1949).

The flora of 20-odd species represents the contributions of taxa from different plant communities. Stream-border vegetation is dominant, and includes species of Persea, Platanus, Populus, Sapindus and a palm. A live oak woodland on bordering slopes was composed of Quercus (cf. wislizenii) and Pinus (sabiniana). Scattered in the woodland were various shrubs, notably species of Ceanothus (cuneatus), Rhamnus (californica), R. (crocea) and Quercus (dumosa). These may have formed local brushy communities scattered in the woodland. Warmer, drier slopes in the region supported a dry tropic scrub composed of Colubrina (glabra), Dodonaea (angustifolia) and Eysenhardtia (orthocarpa). These are now in southern Arizona and adjacent Mexico, as are species of Persea (pododaena), Populus (monticola), and Sapindus (drummondii) that also occur in the flora. All of them attest to the presence of adequate rain in the warm season.

Precipitation was near 20 inches at a minimum. Winters were essentilly frostless as judged from the abundance of Persea (avocado), palm, and other taxa that have their nearest descendants far to the south in mild winter climates.

The flora is 8-9 m.y., or early Hemphillian which is now considered Miocene by some authorities.

Collection. Univ. Calif. Mus. Paleontology.

Axelrod, D. I. The Pliocene Esmeralda flora of west-central Nevada. Wash. Acad. Sci. Journ. 30: 163-174, 1940.

Stirton, R. A. The Nevada Miocene and Pliocene mammalian faunas as faunal units. Pacific Sci. Congr. 6th, Proc. p. 627-640.

Evernden, J. F., D. E. Savage, G. H. Curtis, and G. T. James. Potassium-argon dates and the Cenozoic mammalian chronology of North America. Amer. Jour. Sci. 262: 145-198, 1964.

This small flora, collected at the turn of the last century, comes from a locality south of Coaldale, Nevada, but has not been relocated. The plants are in the lower part of the type Esmeralda Formation, preserved in buff, tuffaceous siliceous shale.

The flora represents a sample of woodland vegetation, with species of Quercus (arizonica, chrysolepis) scattered over the plain, associated with Juniperus (osteosperma), Arctostaphylos (glauca), Cercocarpus (montanus), Mahonia (fremontii) and Peraphyllum (ramosissimum). Streamways and the lake border area supported species of Celtis (reticulata), Populus (trichocarpa), Salix (bonplandiana, exigua) and Umbellularia (californica).

This assemblage implies precipitation was on the order of 18-20 inches in contrast to 4 inches annually at the site today which is in the shadscale desert. The fossil flora also suggests that temperatures were less extreme, with milder winters and summers. Some summer rain probably was present to judge from the occurrence of Celtis, Quercus (arizonica) and also from other taxa of similar requirements in the area 80 miles north at the same time.

Radiometric dates in the Esmeralda Formation (Evernden et al., 1964, p. 164), and the occurrence of a large mammalian fauna of Clarendonian age at several sites (see Stirton, 1939), indicae the flora is Late Miocene (formerly Early Pliocene).

Collection. U. S. Nat. Museum, Wash. D. C.

Furnace Creek

Axelrod, D. I. A record of Lyonothamnus in Death Valley. Jour. Geology 48: 526-531, 1940.

Curry, D. H. Mammalian and Avian Ichnites in Death Valley. Geol. Soc. Amer. Bull. 52: 1979 (abstract), 1941.

Noble, L. F. and L. A. Wright. Geology of the central and southern Death Valley region, California. Calif. Div. Mines and Geol. Bull. 170, Chap. II, p. 143-160, 1952.

The fine-grained sediments of the Furnace Creek Formation, exposed along Highway 190 a few miles southeast of Furnace Creek Inn, Death Valley National Monument, represent playa and lake bed deposits that interfinger with volcanic rocks to the south.

A portion of a leaf of Lyonothamnus recovered from the lake-beds implies that woodland vegetation occupied the region, and that climate was mild and well watered, probably with at least 15-20 inches precipitation in the bordering hills. The abundant mammalian and bird tracks in the playa sediments indicate conditions suited to a rich biome that included species of horse, camelids, canids and others.

The mammals suggest an age in the early Hemphillian, or in the range or 7-10 m.y.

Collection. Univ. Calif. Mus. Paleontology.

Mint Canyon

Axelrod, D. I. The Mint Canyon flora of southern California: a preliminary statement. Amer. Jour. Sci. 238: 577-585, 1940.

Jahns, R. H. Stratigraphy of the easternmost Ventura basin, California, with a description of a new Lower Miocene mammalian fauna from the Tick Canyon Formation. Carnegie Inst. Wash. Pub. 514: 145-194, 1940.

Crowell, J. C. Displacement along the San Andreas fault, California. Geol. Soc. Amer. Spec. Papers 71: 1-61, 1962.

Crowell, J. C. (ed.) The San Andreas fault in southern California. Calif. Div. Mines and Geology, Spec. Rept. 118. 272 pp. 1975 (see papers by Crowell, Howell, Bohannon, Ehlig et al. for displacement).

Evernden, J. F., D. E. Savage, G. H. Curtis, and G. T. James. Potassium argon dates and the Cenozoic mammalian chronology of North America. Amer. Jour. Sci. 262: 145-198, 1964.

This large fossil flora, represented by more than 100 woody species, is preserved in a fine rhyolite tuff in the Mint Canyon Formation (Jahns, 1940). The locality is near the head of Sand Canyon east of Newhall in southern California. Situated west of the San Andreas fault, geologic evidence indicates that the basin was situated in the area of the present Salton Sea when the flora was living (Crowell, 1962; 1975).

The plant assemblage is represented by taxa that contributed to a live oak woodland that covered the moister parts of the basin. The woodland was made up of species of Celtis, Ilex, Juglans, Lyonothamnus, Mahonia, Persea, Platanus, Populus, Salix and Vitis, as well as 5 species of oak. Associated understory shrubs were chiefly sclerophylls, as Arctostaphylos, Ceanothus, Cercocarpus, Fremontodendron, Holodiscus, Laurocerasus, Rhamnus, and Rhus. They no doubt contributed locally to seral chaparral communities.

The lower, drier and warmer parts of the basin were covered with a dry tropic scrub, much like that now in southern Baja California and in coastal Sonora in moister areas above the Sonoran Desert. Among the taxa in this community were species of Acacia, Acalypha, Brahea, Bursera, Cardiospermum, Chiococca, Condalia, Crossosoma, Diospyros, Dodonaea, Eysenhardtia, Fouquieria, Lysiloma, Pithecollobium, Pachycormus, and Robinia.

Climate was semiarid, with precipitation ranging from about 25 inches in the moister parts of the woodland to as low as 15 inches in the drier sectors where the arid tropic scrub was dominant. Rainfall occurred chiefly in the summer months, and winters were mild and frostless as judged from the strong representation of arid tropic scrub taxa, as well as some of the woodland taxa, notably Laurocerasus, Lyonothamnus, Persea and Thouinia.

The flora is dated as Late Miocene by the associated mammalian fossils that range from late Barstovian to Clarendonian in age (Jahns, 1940), indicating an age of about 12 m.yrs. as established by Evernden et al. (1964).

Collection. Univ. Calif. Mus. Paleontology.

Mount Eden

Axelrod, D. I. A Pliocene flora from the Mount Eden beds, southern California. Carnegie Inst. Wash. Pub. 476: 125-183, 1937.

Axelrod, D. I. Further studies of the Mount Eden flora, southern California. Carnegie Inst. Wash. Pub. 590: 73-117, 1950.

Frazer, D.M. Geology of the San Jacinto quadrangle south of San Gorgonio Pass, California. California, Dept. Nat. Resources, Div. Mines, Rept. XXVII of the State Mineralogist 27 (4): 494-540, 1931.

Stirton, R. A. Succession of North American continental Pliocene mammalian faunas. Amer. Jour. Sci. 5th ser., 32: 161-206, 1936 (see for refs. to mammalian fauna).

This large Pliocene flora from the borders of the desert is represented by 47 species. As inferred from the habit of their modern descendants, 18 of the species were trees, the remainder small trees and shrubs. As outlined by Fraser (1931) in his report on the geology of the region, the area was one of considerable topographic relief, though not as high as at present. High hills rose to the south at the site of the present Santa Jacinto Mountains, and there were low hills of granitic rocks within the basin of deposition.

Woodland vegetation dominated the area. It was composed of species that have their descendants in nearby as well as in more distant areas. California taxa in the flora include species of Juglans (californica), Platanus (racemosa), Quercus (agrifolia, chrysolepis, douglasii, engelmannii), Pinus (sabiniana), and with species of Populus (fremontii) and Salix (exigua, lasiolepis) along the stream and lake margins. Also in the woodland were species whose nearest descendants are now in the woodland vegetation in southern Arizona and northern Mexico, notably Arbutus (arizonica), Juglans (rupetris), Persea (podadenia), Populus (monticola), and Sapindus (drummondii).

Diverse sclerophyllous shrubs were scattered in the woodland, and no doubt formed local brushy communities, precursors of the present chaparral that dominates the area. These included species of Arctostaphylos (glauca, pungens), Ceanothus (divaricatus, spinosus), Cercocarpus (betuloides), Prunus (integrifolia), Quercus (palmeri), Rhamnus (ilicifolia) Rhus (ovata). The lower, drier parts of the basin were covered with semidesert scrub, with species of Baccharis (sergiloides), Cercidium (torreyanum), Chilopsis (linearis), Condalia (parryi), Dodonaea (angustifolia), Ephedra (nevadensis), Eysenhardtia (polystacha), Ficus (cotinifolia), Forestiera (neomexicana), and Prunus (fremontii).

A bigcone spruce-Coulter pine forest reached down into the basin from the bordering hills. Its associates included Pinus (attenuata), Philadelphus (lewisii) and Quercus (chrysolepis).

Rainfall was near 25 inches at the lower edge of forest, and probably as low as 15 inches in the drier parts of the basin where semidesert taxa lived. Temperatures were mild and evidently frostless as judged from the occurrence of Eysenhardtia, Dodonaea, Ficus, Persea and others in the flora that require mild winters whose descendants are now found far to the south, or only in coastal California (Ceanothus spinosus, Malosma laurina, Prunus integrifolia).

The flora is Hemphillian in age (7-8 m.y.) as shown by a large mammalian fauna in the Mount Eden Formation (in Stirton, 1936).

Collection. Univ. Calif. Mus. Paleontology; Los Angeles County Mus. Nat. History.

Ricardo

Webber, I. E. Woods from the Ricardo Pliocene of Last Chance Gulch, California. Carnegie Inst. Wash. Pub. 412: 115-134, 1933.

Dibblee, T. W. Geology of the Saltdale quadrangle, California. Calif. dept. Nat. Resources, Div. Mines and Geol. Bull. 160: 7-43, 1952.

Evernden, J. F., D. E. Savage, G. H. Curtis, and G. T. James. Potassium-argon dates and the Cenozoic mammalian chronology of North America. Amer. Jour. Sci. 262: 145-198, 1964.

Stock, C. and E. Furlong. 1926 New canid and rhinocerotid from the Ricardo Pliocene of the Mohave Desert. Univ. Calif. Publ. Dept. Geol. Sci. Bull. 16: 43-60, 1926.

This fossil flora is based on fossil woods from the Saltdale Petrified Forest in Last Chance Gulch, exposed on the south slopes of the El Paso Mountains northeast of Mohave. The flora is preserved in rhyolite tuff in the lower part (Member 2) of the Ricardo Formation (Dibblee, 1952). The petrified forest was made up of a number of standing trees, but these were removed by nurserymen (for landscaping) and rock hounds in the early 1950's.

The fossil woods represent species of palm (probably Sabal), Pinus (pinon), Cupressus (cf. arizonica), Quercus (evergreen oak) and Robinia (locust). The plants contributed to an oak-pinon woodland like that near the lower margin of the community in southern Arizona and adjacent Sonora today.

The flora implies precipitation was near 20-23 inches, and summer rain was present. Frost probably were absent as judged from the palm, and from the abundance of Persea (avocado) in the somewhat younger Anaverde flora a few tens of miles to the south.

The flora is Late Miocene in age, about 10 m.y. as dated by Evernden et al. (1964, p. 177). Fossil mammals, including horse, canid, rhinocerotid, and proboscidean remains, occur above and below the flora (Stock and Furlong, 1926), and represent the Clarendonian Stage.

Collection. Univ. Calif. Mus. Paleontology.

Tehachapi

Axelrod, D. I. A Miocene flora from the western border of the Mohave Desert. Carnegie Inst. Wash. Pub. 516: 1-129, 1939.

Buwalda, J. P. New mammalian faunas from Miocene sediments near Tehachapi pass in southern Sierra Nevada. Univ. Calif. Geol. Sci. Bull. 10: 75-85, 1916.

Buwalda, J. P. Geology of the Tehachapi Mountains, California. In Geology of Southern California, Calif. Div. Mines and Geol. Bull. 170, Chap. 2, 131-142, 1952.

Evernden, J. F., D. E. Savage, G. H. Curtis, and G. T. James. Potassium-argon dates and the Cenozoic mammalian chronology of North America. Aemr. Jour. Sci. 262: 145-198, 1964.

This large fossil flora, composed of some 70-odd species, is preserved in rhyolite tuff that is interbedded with andesite mudflow breccias and flows that represent the Kinnick Formation. The flora occurs at old mine workings on the east side of Sand Canyon.

Woodland vegetation dominated the area, being composed of species of Pinus (pinon), Cupressus, Arbutus, Brahea (=Erythea), Lyonothamnus, Persea, Pithecollobium, Platanus, Populus, Quercus (4 sp), Sabal, and Umbellularia. Associated small trees in the woodland included species of Bumelia, Celtis, Heteromeles, Leucanea, Myrica, Prunus, Salix. In addition, there was a large shrub component as an understory in the woodland, made up of species of Amorpha, Arctostaphylos, Ceanothus, Cercocarpus, Chamaebataria, Dodonaea, Fraxinus, Fremontodendron, Karwinskia, Mahonia, Prunus, Quercus, Rhamnus, Rhus and Robinia. No doubt some of these contributed to local stands of chaparral is restricted dry sites. A large thorn-scrub component is also represented in the collection, as shown by species of Bursera, Colubrina, Condalia, Diphysa, Dodonaea, Euphorbia, Ficus, Karwinskia, Leucanea, Pithecolobium, and Prosopis. This vegetation occupied the drier and warmest parts of the basin at lower elevations.

The affinities of the flora lie in several regions--southern California (insular chiefly), southern Arizona, Sonora, and the Cape Region of Baja California. The assemblage indicates rainfall was near 25 inches, mostly distributed in the warm season, and probably with semidesert sites in areas where the dry tropic scrub live under about 15 inches precipitation. Temperatures were mild in summer and frost was absent as judged from the occurrence of numerous taxa (e.g. Brahea, Ficus, Leucanea, Karwinskia, Persea, Sabal, etc.) that are restricted to frost-free areas today.

The flora is Middle Miocene in age as shown by the associated mammalian (Hemingfordian) fauna described by Buwalda (1916), and by a potassium-argon date of 17 m.yrs. (Evernden et al. 1964).

Collection. Univ. Calif. Mus. Paleontology

Miscellaneous

Several sites in the region have yielded remains of one or two Miocene fossil plants. They are not of sufficient importance to have been described, though it is possible that larger collections may be obtained which might yield significant paleoecologic data. The following records are based on collections in the Univ. Calif. Mus. Paleontology.

1. East side of Providence Mts., Ivanpah Quadrangle, 5 miles north of Bonanza King Mine. Fossil coniferous wood in basal conglomerate of Lower Miocene volcanics.

2. Opal Mountain, Barstow syncline. Palm leaves in fine shale in SE 1/4 Sec. 1, T. 11 N, R. 2 E.

3. Eureka Quarry, Barstow syncline area. Charophyte oogonia in lake beds in SE 1/4, SE sec. 9, T. 11 N., R. 2W.

4. Artillery Mountains, Artillery Formation, Palm leaves. Area described by Laskey, S. G. and B. N. Webber, Manganese resources of the Artillery Mountain region, Mohave County, Arizona, U. S. Geol. Surv. Bull. 961. 1949.

PLEISTOCENE (EARLY)

Soboba

Axelrod, D. I. The Pleistocene Soboba flora of southern California. Univ. Calif. Pub. Geol. Sci. 60: 1-79, 1966.

Frick, C. Extinct vertebrate faunas of the badlands of Bautista Creek and San Timoteo Canon, southern California. Univ. Calif. Publ. Geol.12: 277-424, 1921.

Evernden, J. F., D. E. Savage, G. H. Curtis, and G. T. James. Potassium-argon dates and the Cenozoic mammalian chronology of North America. Amer. Jour. Sci. 262: 145-198, 1964.

Fraser, D. M. Geology of the San Jacinto quadrangle south of San Gorgonio Pass, California. Calif. Div. Mines. Rept. XXVII State Mineralogist, vol. 27 (4): 494-540, 1931.

This, the largest pre-Wisconsin Pleistocene flora presently known from North America, occurs in the semidesert San Jacinto basin, not far from the "Colorado Desert" which forms the northwestern arm of the Sonoran Desert. The plants are preserved in fine silty claystone in the lower part of the Bautista Formation (Frick, 1921), below a large mammalian fauna. The formation rests on the metamorphic granitic basement, and is sliced by the San Jacinto fault zone (Fraser, 1931).

The flora records an early glacial-pluvial stage, for it is dominated by forest taxa that now live in the mountains 3,000 ft. higher. These include members of the yellow pine forest, notably Abies concolor, Pinus lambertiana, P. ponderosa, Calocedrus decurrens, Populus tremuloides, Quercus morheus, Ribes nevadense, Amelanchier alnifolia, Ceanothus integerrimus, and Symphoricarpos rotundifolius. They must have lived near at hand for winged seeds as well as abundant remains of foliage are represented. Warmer slopes in the nearby area were covered with bigcone spruce forest, as shown by the remains of Pinus coulteri, Pseudotsuga marcrocarpa, Cupressus forbesii, Amorpha

californica, Arbutus menziesii, Quercus chrysolepis, Q. wislizenii, and Mahonia dictyota, most of which are also well represented.

More exposed and drier slopes in the area were covered with an oak woodland, as shown by Quercus wislizenii, and its associates included diverse shrubs that also contributed to patches of chaparral, as Ceanothus ceunatus, C. leucodermis, C. tomentosus, Cercocarpus betuloides, Quercus dunnii, Q. dumosa, Garrya flavescens, Prunus ilicifolia, and Rhus ovata.

Stream and lake-border vegetation formed dense woodlands composed of Acer negundo, Cornus californica, Fraxinus velutina, Platanus racemosa, Populus fremontii, P. trichocarpa, and Salix laevigata.

It is noteworthy that there are two relict taxa in the flora that indicate some summer rain was present, as implied by Acer brachypterum and Magnolium grandiflora.

As judged from the nature of the assemblage, precipitation was near 30 inches as compared with 13 in the basin today. Summer and winter temperatures were more moderate, and mean temperature was on the order of 9-10°F lower than at present.

The age of the flora, as judged from its climatic indications and from an associated mammalian fauna at a higher stratigraphic level (Frick, 1921), is Early Pleistocene and Early Irvingtonian which is dated near 1.3 m.y. (Evernden et al., 1964, p. 164).

Collection. Univ. Calif. Mus. Paleontology; Univ. Calif. Riverside, Dept. Earth Sciences.

PLEISTOCENE (LATE)

Woodrat (Neotoma) Midden Floras

Considerable research has been conducted on woodrat middens which can be dated by radiocarbon back to about 40,000 years before the present (B.P.). The value of woodrat middens as a record of past environments lies in the fact that the material is gathered by Neotoma from the nearby area, probably less than 100 meters away for the foraging rats. Since the midden accumulates rapidly, a narrow time span is represented in most cases. The material collected by the woodrats is macroscopic, including conifer needles and twigs, cones, leaves, branchlets, and some fruiting material and flowers, most of which can be identified to species. Thus, the many uncertainties of pollen analyses are eliminated for this part of the record at least.

In general, the evidence shows that woodland vegetation covered much of the present desert area during the last glacial, from 23,000 to about 12,000 years ago, with juniper and pinyon pine widespread in many areas. At that time desert taxa were greatly reduced in number, either by confinement to local dry sites, or by their shift southward to warmer climates, or to both factors.

Apart from the records that document the lower level of woodland in the present desert region, there also are records of woodrat middens from higher elevations in the desert ranges that show forest reached down to much lower levels than at present.

Artillery Mountains

Van Devender, T. R. and J. E. King. Late Pleistocene vegetational records in western Arizona. Ariz. Acad. Sci. Jour. 6: 240-244, 1971.

Three woodrat middens recovered from the Artillery Mountains western Arizona, are dated at +30,000 B. P., 18,320 + 400, and 10,250 + 200 B. P. They reveal the gradual dessication of the region. The older unit records a downward displacement of woodland vegetation, dominated by pinyon and juniper with sagebrush, at least 300 meters and probably as much as 600 meters, below the present lower limit of woodland. The woodland was present in the area until after 18,00 B. P. Then Pinus monophylla became rare and Juniperus monosperma replaced J. osteosperma (colder requirements) as the dominant woody plant. By 10,000 B. P., as climate became warmer and drier, juniper grassland with scrub oak (Q. turbinella) and Ceanothus was predominant. The present Sonoran Desert vegetation was established in the Artillery Mountains after 10,000 B. P.

Collection. Geochronology Laboratory, Univ. Arizona, Tuscon.

Clark Mountain

Mehringer, P. J. and C. W. Ferguson. Pluvial occurrence of bristlecone pine (Pinus aristata) in a Mohave Desert mountain range. Ariz. Acad. Sci. Jour. 5 (4): 284-292, 1969.

The remains of 3 woodrat middens have been described from a cave on the xeric, south side of Clark Mountain at an elevation of 1910 meters in pinyon-juniper woodland. The two oldest middens, dated at 28,700 and 23,600 ± 1,000 B. P. contain abundant needles of bristlecone pine (Pinus aristata) and limber pine (P. flexilis), and account for most of the material in the middens. Needles of white fir (Abies concolor) as well as a few twigs of Juniperus osteosperma are also present, but Pinus monophylla has not been found.

The third sample, dated at 12,460 ± 190 B. P., has twigs of Juniperus osteosperma and needles of Pinus monophylla as the most abundant remains. White fir and limber pine are present but rare, and bristlecone pine was not observed.

Pinus aristata and P. flexilis are not now in the Clark Mountain and Abies concolor is very rare there as a relict stand. Comparison with altitudinal distribution of these trees in the Spring (Charleston) Mountains, 50 miles north in nearby Nevada, indicates a depression of the species 500 meters at a minimum, implying a much wetter and cooler climate. Furthermore, the pinon from the younger deposit has much wider growth rings than those that occur on Clark Mountain at present.

Collection. Univ. Arizona, Geochronology Laboratories, Tuscon.

Funeral Mountains

Wells, P. V. and R. Berger. Late Pleistocene history of coniferous woodland in the Mohave Desert. Science 155: 1640-1647, 1967.

A woodrat midden from an elevation of 1260 meters in the arid Funeral Mountains on the east side of Death Valley has been dated at 11,600 ± 160 years. It is dominated by the remains of Juniperus osteosperma and Prunus fasciculata. Associated taxa include Cercocarpus ledifolius, Fraxinus anomala, Artemisia nova, Cercocarpus intricatus, Encelia virginensis, Ephedra viridus, Fallugia paradoxa, Ribes montigenum, Symphoricarpos longiflorus, Nolina parryi, and Opuntia erinaceae. Of these, Juniperus, Cercocarpus, Fraxinus, Ribes, and Nolina, are no longer living in the Funeral Range. Clearly, climate was moister than at present in this now desert region, and at the site probably totalled no less than 15-18 inches.

Collection. Univ. Kansas, Dept. Botany

Lucerne Valley

King, T. J., Jr. Late Pleistocene-Early Holocene history of coniferous woodlands in the Lucerne Valley region, Mohave Desert California. Great Basin Naturalist 36: 227-238, 1976.

Two sites in Lucerne Valley, Nos. 10 and 13, at an elevation of 1,006 m. and dated at 11,000 and 12,000 ± 400 B. P. reveal the presence of Juniperus in small amount. Associates at these sites differ somewhat. At site No. 10 are taxa like Dalea, Ephedra, Opuntia, and several perennials, at Site No. 13 are Dalea, Encelia, Ephedra, Penstemon and a few annuals. Both suggest conditions near the lower margin of Juniperus woodland, and imply drier conditions than those indicated by the midden at a higher level, and on the north (cooler) slope in the Ord Mountains. It is apparent that local terrain and microclimates controlled the distribution and composition of the woodlands, much as they do today.

Sites No. 11 and 14, dated at 8300 ± 780 and 7800 ± 350, reveal the persistence of juniper to this late date over the valley proper at an elevation of 1,006 m. together with various herbaceous and perennial taxa (Amsinckia, Astragalus, Atriplex, Cirsium, Castilleja, Encelia, Ephedra, Eriogonum, Lomatium, Lycium, Opuntia, and Purshia. Younger middens in the area show that Larrea appeared later, in woodrat nests dated at approximately 6,000 B. P., and which in Juniperus, Purshia, etc. are no longer present.

Collection. Univ. California, Riverside. Dept. of Archaeology.

Negro Butte

Wells, P. V. and R. Berger. Late Pleistocene history of coniferous woodland in the Mohave Desert. Science 155: 1640-1647.

This assemblage from an elevation of 1070 m. in the southern Mohave Desert is dated by radiocarbon as 9,140 ± 140 years. It is dominated by Juniperus osteosperma twigs, seeds and wood. Associates include species of Artemisia nova, Ephedra viridus, Haplopappus cuneatus, Purshia glandulosa (abundant), Yucca brevifolia, and Opuntia erinacea. This area in Lucerne Valley is covered with desert vegetation today, and implies that at the time of Neotoma accumulation rainfall was at least 5-7 inches higher than at present, and also cooler.

Collection. U. Kansas, Dept. Botany.

Newberry Cave

van Devender, T. R. Holocene woodlands in the Southwestern deserts. Science 198: 189-192, 1977.

The occurrence in the eastern Mohave region of several wood rat middens is also recorded by van Devender from Redtail Peaks at an elevation of 500 m. He notes that they are dated at 9600 ± 170 years, and contain Juniper, Nolina and Yucca brevifolia, and indicate a moister climate than that presently in the area.

Collection. Univ. Arizona, Geochronology Laboatories.

Newberry Mountains

Leskinen, P. H. Occurrence of oaks in Late Pleistocene vegetation in the Mohave Desert of Nevada. Madrono 23: 234-235, 1935.

Woodrat middens in the Newberry Mountains have yielded the remains of Quercus chrysolepis and Q. dunnii as well as Pinus monophylla and Juniperus californica, together with remains of Acacia, Purshia and Yuccca. These lived in the area from 13,380 ± 300 years B. P., to 9,500 ± 240 years B. P. The evidence indicates the depression of the woodland belt fully 300 meters at a minimum below that of the present. In addition, the oaks noted above are no longer in the region, but occur in western Arizona and in southern California. This attests to the profound changes that have occurred in the region only recently, and chiefly in response to the trend to increased aridity following the last pluvial.

Collection. Dept. Geography, Bowling Green State Univ., Bowling Green, Ohio.

Ord Mountain

King, T. J., Jr. Late Pleistocene-early Holocene history of coniferous woodlands in the Lucerne Valley region, Mohave Desert, California. Great Basin Naturalist 36: 227-238, 1976.

The midden from this site is at an elevation of 1,219 m., dated at 11,850 ± 550, and is in a region presently covered with typical Mohave Desert vegetation of Larrea, Ephedra, Chrysothamnus, Gutierrezia, Haplopappus, Hymenoclea and Salazaria. The remains from the midden include abundant Juniperus osteosperma and common Pinus monophylla as well as Purshia glandulosa and several other woody perennials. This assemblage now lives at higher levels in the region where precipitation totals 15-18 inches at a minimum. Pinon and juniper are not now in the Ord Mountains, indicating a considerable reduction in moisture in the region since 11,000 B. P.

Collection. Univ. Calif., Riverside, Dept. Archaeology.

Sheep Range, southern Nevada

Spaulding, W. G. Late Quaternary vegetational change in the Sheep Range, southern Nevada. Ariz. Acad. Sci. Jour. 5 (4): 284-292, 1969.

1. The Long Canyon Saddle midden, at an elevation of 1800 m, is dated at 30,400 ± 1500 years, as based on Juniperus osteosperma twigs. Aside from the abundant juniper twigs, the most notable macrofossils in the middle are leaves on Abies concolor and Pinus flexilis. These are restricted now to sites above 2400 m in the Sheep Range. Modern vegetation around the present site is dominated by Gutierrezia and Coleogyne, and with Artemisia tridentata, Ephedra viridis and Symphoricarpus longiflorus in more mesic north-facing habitats. The assemblage shows that the forest level was considerably lower than that of today, and implies a much cooler and moister climate than at present.

2. The South Crest midden is from a xeric southeast-facing slope at 1980 m elevation. Limber pine and bristlecone pine needles are radiocarbon-dated at 21,700 ± 500 years. Along with these montane pines were needles of Abies concolor and Ribes montigenum. Today, bristlecone pine is confined to levels above 2400 m in the Sheep Range. The modern flora near the midden area is composed of Artemisia tridentata, Cercocarpus intricatus, Rhus trilobata, Symphorcarpos longiflorus, and Yucca breviflora. Clearly, there is ample evidence here for a much wetter and a cooler climate as well.

Collection. Univ. Arizona, Geochronology Laboratories.

Turtle Mountains

Wells, P. V. and R. Berger. Late Pleistocene history of coniferous woodland in the Mohave Desert. Science 155: 1640-1647, 1967.

Neotoma middens in the eastern Mohave region have been recovered at two sites in the Turtle Mountains, at elevations of 850 and 730 meters. The former, dated at 19,500 ± 380 years, has abundant Juniperus osteosperma and Pinus monophylla. The richer accumulation at the lower site, dated at 13,900 ± 200 yrs., is also dominated by juniper and pinyon pine. Associates include Artemisia nova, Cercocarpus intricatus, Ephedra viridus, Ribes velutinum, and Opuntia erinacea which is also abundant. These records clearly document a moister climate for the area is to dry for juniper-pinon woodland in the Turtle Mountains today.

Collection. U. Kansas, Dept. Botany.

Whipple Mountains

van Devender, T. R. Holocen woodlands in the Southwestern desert. Science 198: 189-192, 1977.

In his survey of the wood-rat middens of the Southwest, van Denvender recorded the presence of Juniperus and Nolina in two woodrat middens in the arid Whipple Mountains. Situated west of Parker Dam at an elevation of 520 m, the middens are dated at 10,000 years by radiocarbon. They clearly indicate that the area was much more mesic than it is at present.

Collection. Univ. Arizona, Geochronology Laboratories.

MICROFOSSIL (POLLEN) FLORAS

Several pollen floras have been described from the northwestern part of the province, in the area from Lone Pine eastward to Panamint Valley.

PLIOCENE

Coso

Axelrod, D. I. and W. S. Ting. Late Pliocene floras east of the Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 1-118, 1960.

Hopper, R. H. Geologic section from the Sierra Nevada to Death Valley, California. Geol. Soc. Amer. Bull. 58: 393-432, 1947.

Schultz, J. R. A late Cenozoic vertebrate fauna from the Coso Mountains, Inyo County, California. Carnegie Inst. Wash. Pub. 487: 75-109, 1937.

Evernden, J. F., D. E. Savage, G. H. Curtis, and G. T. James. Potassium-argon dates and the Cenozoic mammalian chronology of North America. Amer. Jour. Sci. 262: 145-198, 1964.

This flora comes from the type area of the Coso Formation, exposed on the east side of Haiwee Reservoir in the foothills of the Coso Range. The locality is on the south side of the Cactus Flat Road at an elevation of 4,400 ft. The geology of the area (Hopper, 1947) shows that the Coso Formation rests on a grantic basement and is overlain by basalt flows. The fossil pollen comes from fine mudstones interbedded with sandy limestones and soft brown and tan shale.

The pollen represents forest vegetation, chiefly trees of the west slope of the Sierra Nevada. Sierran mixed conifer forest taxa include Abies concolor, Pinus lambertiana, P. ponderosa, Pseudotsuga menziesii, Sequoiadendron giganteum, Libocedrus decurrens, associated with Alnus rhombifolia, Amelanchier alnifolia, Ceanothus integerrimus, Cornus nuttallii, Corylus californica, Fremontodendron californicum, Quercus kelloggii, Q. wislizenii, and Ribes spp. This community appears to have occupied the lowlands of the area. There also

are records of a subalpine forest in the region, including species of Abies magnifica, Pinus aristata-flexilis, P. jeffreyi, P. monticola, P. murrayana, Ceanothus cordulatus, Ribes montigenum. These probably were transported to the area from the Sierran rise a few miles to the west.

There are no records in the flora of the present desert vegetation that now typifies the area of the Coso Range.

Climate was moist and temperate, with probably 30-35 inches precipitation and with cool winters with regular snow and frost.

The flora is Late Pliocene in age, and has been dated as Late Blancan by a large mammalian fauna (Schultz, 1937), and by radiometric evidence as 2.1 m.y. (Evernden et al., 1964).

Collection. U. C. L. A. palynological collection.

Darwin Summit

Axelrod, D. I. and W. S. Ting. Late Pliocene floras east of the Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 16-17, 1960.

This small flora comes from the area east of Haiwee Reservoir, on State Highway 190, one mile WNW of the Darwin turnoff. The microfossils were recovered from relatively fine sandstone associated with coarse sedimentary rocks that lie under the widespread basalt in the region. The sedimentary rocks, about 200 feet thick, are considered contemporaneous with the Coso Formation.

The flora provides a record of the Sierran forest in the region, as shown by species of Pinus ponderosa, Sequoiadendron giganteum, Libocedrus decurrens, Cornus nuttallii, Ribes roezlii, Salix lasiolepis, and Symphoricarpos albus. A few subalpine taxa are present, notably Pinus flexilis (or aristata), and Ceanothus cordulatus. Their pollen probably was carried into the area from the Sierra Nevada to the west. Drier sites in the area supported Pinus cf. monophylla and Juniperus oestosperma, indicating the increasing importance of woodland vegetation to the east as rainfall decreased in the lee of the Sierra.

Rainfall in this presently desert area was then near 30 inches, distributed as winter rain and snow. Summers were warm but the temperature extremes of the present day had not yet developed.

It is emphasized that this small flora provides no record of taxa that contribute to desert vegetation.

It is considered contemporaneous with the Haiwee flora, or late Blancan, about 2 m.y. old.

Collection. U.C.L.A. palynological collection.

Crowley Point

Axelrod, D. I. and W. S. Ting. Late Pliocene floras east of the Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 18-20, 1960.

This florule is somewhat larger than the Darwin Summit flora, and occurs several miles to the east along State Highway 190 at an elevation of 33,880 feet, 0.6 miles SSE of Crowley Point lookout. The sample comes from the upper part of a 25-foot section of the Coso Formation that underlies the widespread basalt in the region. The Coso rests on Permian limestones in this area.

The flora includes numerous west-slope taxa that make up the present mixed conifer forest, notably Pinus lambertiana, P. ponderosa, Pseudotsuga menziesii, Ceanothus intergerrimus, Cornus californica, C. sessilis, Mahonia sp., Populus trichocarpa, Salix lasiandra, Quercus kelloggii, Ribes nevadense, Rosa, sp. A larger number of woodland taxa are present in this area, notably Pinus cf. monophylla, Juniperus osteosperma, Cercocarpus betuloides, Fremontodendron californicum, and Rhamnus crocea.

Subalpine taxa are reduced in this more easterly position, farther from the Sierran source. Among the taxa recognized are Pinus aristata (or flexilis), Juniperus occidentalis, both represented by single grains, as well as Ceanothus cordulatus, and Ribes viscosissimum.

It is inferred that precipitation was somewhat lower in this area as compared with the floras to the west, probably totalling 25 inches, and with woodland vegetation dominating the drier slopes where precipitation was below 25 inches.

This flora is Pliocene in age, contemporaneous with the Haiwee and Darwin Summit floras to the west.

Collection. U.C.L.A. palyn. collection.

Panamint Spring

Axelrod, D. I. and W. S. Ting. Late Pliocene floras east of the Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 20-21, 1960.

This florule comes from a section exposed 0.6 miles west of Panamint Spring on the north side of Highway 190. The section there consists of about 100 feet of fanglomerate, conglomerate, sandstone and grit resting on granodiorite and covered by about 120 feet of basalt flows. The fossils are preserved in a finer sandstone directly under the basalt.

The assemblage is much like that which can be found today in the forest-woodland transition in southern California and bordering areas. Members of the yellow pine forest include Pinus ponderosa, P. jeffreyi, Quercus kelloggii and Ribes cereum. These taxa often mingle with Pinus coulteri, P. attenuata, Garrya, Fremontodendron, and Fraxinus velutina, as on the City Creek road above Redlands and also on the desert slopes near Wrightwood, in the San Gabriel Mountains. Pinus cf. monophylla is at the lower margin of forest in this area. Quercus lobata mingles with most of these taxa in the Mt. Pinos region where Fremontodendron is especially abundant in the chaparral.

The assemblage is drier than those to the west, and implies conditions like those at the forest margin where precipitation is near 23-25 inches as an average. Winters were cold, with regular though light frost, and summers were warmer than in the Coso area 30 miles west.

Collection. U.C.L.A. palyn. collection.

Nova

Axelrod, D. I. and W. S. Ting. Late Pliocene floras east of the Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 21-24, 1960.

This flora comes from finer silts interbedded in the Nova Formation on the east side of Panamint Valley. This formation, some 3,000 feet thick, represents chiefly angular fanglomerate derived from a rising mountain area in the Late Pliocene.

The fossil flora of some 22 pollen grians, is much like the Panamint Springs sample, 15 miles to the west. The Sierran forest is represented by Abies, concolor, Pinus lambertiana, P. ponderosa, Alnus rhombifolia, Ceanothus cordulatus, Corylus californica and Rhamnus californica. Woodland vegetation is represented by Pinus cf. monophylla, and Juniperus osteosperma together with their usual associates, notably species of Cercocarpus, Ephedra, Holodiscus, Juglans, Populus and Salix. Note also that grains of Chenopodiaceae and Compositae are represented in some numbers, and probably were scattered in the woodland. Most of these plants can be found today in proximity, as in the San Gabriel Mountains near Wrightwood where the Sierran mixed conifer forest meets the pinyon-juniper woodland.

As compared with 2-3 inches precipitation in the Nova area today, the fossil flora indicates rainfall was near 20-23 inches. Summer temperatures were considerably lower than those now in the region.

All of the pollen floras noted above have one or two records of taxa that are now in summer rain areas, either in eastern United States or Asia (Pterocarya, Ulmus, Zelkova), or in the southwestern United States (Juglans cf. rupestris). This is consistent with the occurrence of similar taxa in floras of essentially the same age farther north on the east side of the Sierra, and also in the coastal strip in the Late Pliocene. Summer rain was then sufficient to support only a few relicts in the region.

Collection. U.C.L.A. palyn. collection.

PLEISTOCENE (EARLY)

Alabama Hills

Axelrod, D. I. and W. S. Ting. Early Pleistocene floras from the Chagoopa surface, southern Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 21-24, 1960.

Duffield, W. A. and G. I. Smith. Pleistocene river erosion and intercanyon lava flows at Little Lake, Inyo County, California. California Geology 3 (4): 81-89, 1978.

This pollen flora was recovered from old, weathered red and gray fine sediment about 25 feet thick that rests on the granitic basement 1.5 miles south-southwest of Lone Pine, along the road to Whitney Portal. The section is exposed in the road-cut and banks of Lone Pine Creek, and is overlain unconformably by old alluvial fan from the Sierra Nevada.

In terms of plant communities the following major forest zones are represented in the flora. A Sierran mixed conifer forest is represented by Abies concolor, Pinus lambertiana, P. ponderosa, Pseudotsuga menziesii, Libocedrus decurrens, Alnus rhombifolia, Amelanchier sp., Ceanothus cordulatus, Cornus californica, Corylus californica, Prunus emarginata, Rubus parviflorus, Salix lasiolepis, and Symphoricarpos albus. These account for over 53 per cent of the grains recovered. Fir and subalpine forest are represented by Abies concolor, Pinus aristata, P. murayana and Ceanothus cordulatus. In addition, there are several taxa that represent Coast forest taxa, probably derived from the west side of the range, notably Abies grandis and Castanopsis chrysophylla. Unidentified grains of several families, notably Leguminosae, Caryophyllaceae, Cruciferae and Compositae are represented.

The vegetation recorded by the fossil pollen assemblage differs greatly from that in the area today which is Great Basin desert vegetation. To the west, it gives way to a pinon-juniper woodland which is not represented in

the pollen sample. At higher levels, and reaching down the canyons, is an impoverished Sierran mixed conifer forest that lacks a number of taxa that are on the western side of the range. The absence from the flora of taxa representing oak woodland or chaparral vegetation implies that the forest sample was derived from vegetation well up in the mixed conifer forest, consistent with the strong representation of the Fir forest in the pollen record.

Whereas the present area receives 6-7 inches rainfall, the fossil flora implies precipitation was on the order of 35-40 inches because several of the taxa are quite mesic in their requirements, notably Abies concolor, Pinus lambertiana and Pseudotsuga menziesii. Temperatures were cooler in summer and probably not so cold in winter.

There is no record in this sample of the present semidesert vegetation.

The age of the sample can be dated indirectly by correlation with the similar old fan deposits at Little Lake to the south which are overlain unconformably by basalt flows that are dated at 486,000 ± 108,000 yrs. (Duffield and Smith, 1978), and imply a Middle Pleistocene or older age for the flora.

Collection. U.C.L.A. palyn. collection.

Little Lake

Axelrod, D. I. and W. S. Ting. Early Pleistocene floras from the Chagoopa surface, southern Sierra Nevada. Univ. Calif. Publ. Geol. Sci. 39: 1191-194, 1961.

Dalyrymple, G. B., A. Cox, and R. R. Doell. Potassium-argon age and paleomagnetism of the Bishop Tuff, California. Geol. Soc. Amer. Bull. 76: 665-674, 1965.

Duffield, W. A. and G. I. Smith. Pleistocene river erosion and intercanyon lava flows at Little Lake, Inyo County, California. California Geology 3 (4): 81-89, 1978.

This small pollen flora was recovered from fine sediment that rests on the granitic basement and is overlain by younger alluvial fan material in the area 0.5 miles west of Little Lake, exposed along the road that parallels the Los Angeles aqueduct. The well-indurated section is composed of coarse to fine sandstone, mudflow breccia and conglomerate and rests on granodiorite. The microfossils were recovered from the top of the second white sandstone.

Two major plant communities are represented in the collection. Mixed conifer forest is composed of Abies concolor, Pinus lambertiana, P. ponderosa, Alnus rhombifolia, Quercus chrysolepis, Rubus parviflorus, and Salix scouleriana. A fir-subalpine forest is also represented, as shown by Abies concolor, A. magnifica, Pinus aristata, P. monticola, P. murrayana, and Tsuga mertensiana. The former is represented by 211 grains (55%), the latter by 172 grains (45%).

The area now in the Larrea-covered Mohave Desert, yet the sample provides no evidence of any taxa of that community. Nor are there any records of the pinyon-juniper woodland that lies below the conifer forests on the east slopes of the Sierra Nevada in this area today. Clearly, there have been major environmental changes in the region in the Pliestocene.

The flora suggests rainfall was near 30-35 inches in the mixed conifer forest, and that the decrease to the present 5-6 inches at the site occurred after some uplift of the Sierran range, and after the last pluvial period. The age of the flora is uncertain, though it may correspond in time to the Sherwin Till. This is implied by the basalt flow that unconformably overlie the old alluvial gravels in this area, and which have been dated in range of 486,000 years B.P. ± 108,000 years. The uncertainty in radiometric age dating owes to the nature of the basalt and its minerals (Duffield and Smith, 1978; also refs. there). The old alluvial fan in which the pollen occurs has weathering features similar to the Sherwin Till which lies below the Bishop Tuff, dated at 700,000 B. P. (Dalyrymple, Cox and Doell, 1965).

Collection. UCLA polynological collection.

Searles Lake

Roosma, A. A climatic record from Searles Lake, California. Science 128: 176, 1958.

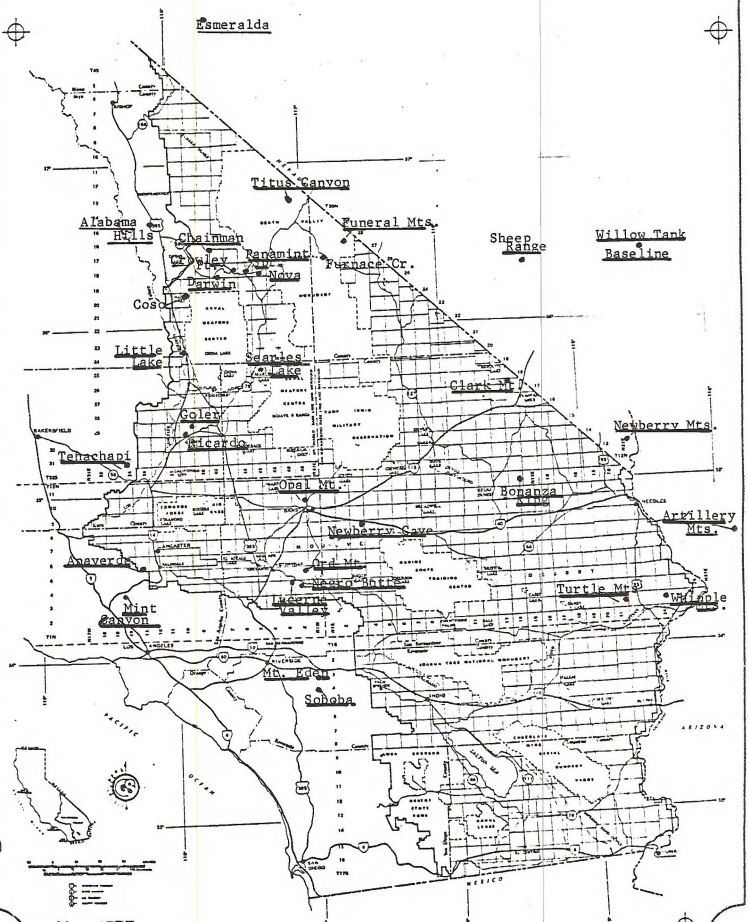
Cores that are over 100 feet in length taken from near the middle of saline flats of Searles Lake have yielded pollen that provides evidence of vegetation and climatic change during and since the last glaciation. The data show that juniper woodland dominated at levels below 95 feet, and that it decreases progressively at higher levels, giving way to the present desert vegetation at higher levels. The Compositae reach a high representation only in the upper saline levels. A shift toward a more intensified drier climate above 50 foot level is indicated by the decrease in the percentage of Artemisia and the rise of chenopods.

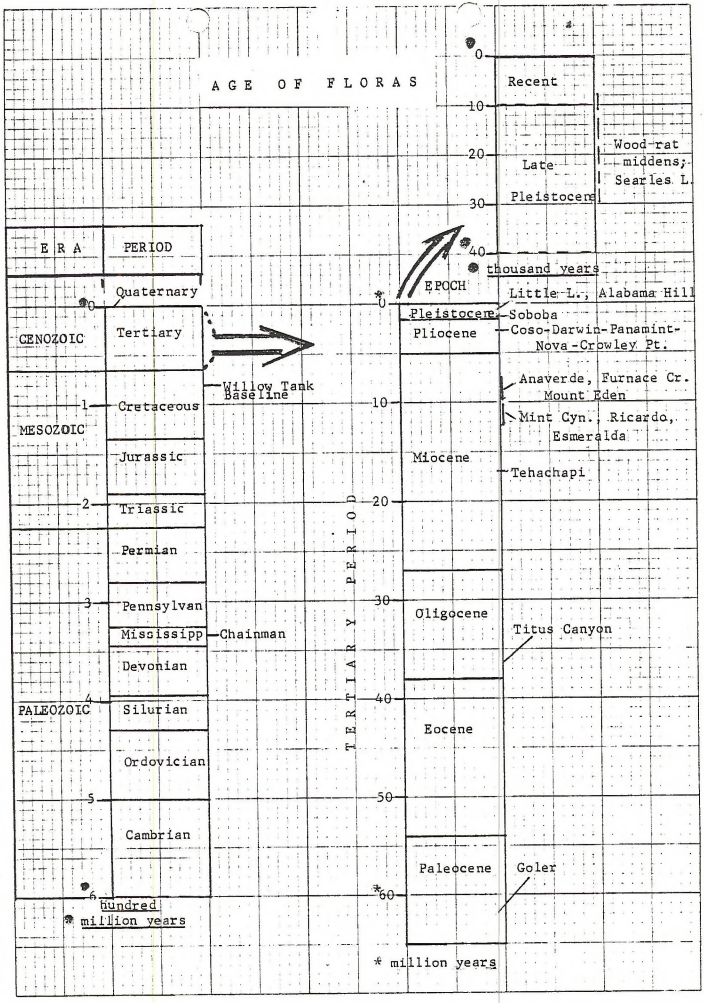
The mesic levels below 95 feet evidently correspond to the Wisconsin glacial, whereas the Thermal maximum or Xerothermic reaches its acme at a depth near 30 feet, a time dated generally at about 5,000 years before the present (B.P.).

The sequence indicates that juniper woodland, which is now some 40 miles distant and 3,500 feet higher in elevation, lived close to the edge of the Searles Lake at the time of the glacial maxima. This is consistent with evidence provided by the floras from the woodrat middens discussed above.

Collection. Botany Dept., Yale University.

CALIFORNIA DESERT CONSERVATION AREA




AGE OF FLORAS
Recent
Late Pleistocene
Wood-rat middens; Searles L.
thousand years
ERA
PERIOD
EPOCH
Quaternary
Pleistocene
Little L., Alabama Hill
CENOZOIC
Tertiary
Pliocene
Soboba
Coso-Darwin-Panamint-Nova-Crowley Pt.
Willow Tank
Baseline
Anaverde, Furnace Cr. Mount Eden
Cretaceous
MESOZOIC
Mint Cyn., Ricardo, Esmeralda
Jurassic
Miocene
Tehachapi
Triassic
Permian
TERTIARY PERIOD
Pennsylvan
Mississipp
Chainman
Oligocene
Titus Canyon
Devonian
PALEOZOIC
Silurian
Eocene
Ordovician
Cambrian
Paleocene
Goler
hundred million years
* million years